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AUTHOR Merryman, Sandra; Seitz, Sue
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ABSTRACT

Reviewed was a 4 year project in which factors influencing learning in the mentally retarded were investigated by means of comparative studies on guided or prompted learning (P) and confirmation or trial and error learning (C). Previous research on P and C was summarized briefly. Examined were seven paradigmatic studies from the project which failed to show a clear superiority of either P or C. Reported was a subsequently applied study in which Ss were taught basic arithmetic skills under the following training conditions: all P, all C, P followed by C, C followed by P, and alternation of P and C. Data showed a lack of large differences in the effectiveness of various training conditions, all of which were thought to have contributed to an increased rate of learning for pupils. Practical implications for teachers of the mentally retarded were drawn in relation to pace of presentation, set for long retention interval, verbalization, intervening tests, expectancy of success, importance of particular rewards to the learner, interference resulting from similarity within the task, training method as a means of distinguishing tasks, diagnostic nature of training materials, and learner ability. (GW)

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Sandra Merryman and Sue Seitz
Austin State School
Austin, Texas

August 1972

The research reported herein was performed pursuant to a grant with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

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Acknowledgments

The project reported here includes work done over a period of some four years. Many people have contributed time, energy, and reflection to that work, and we want to make apparent our gratitude for their help.

Our work has overlapped the tenures of four superintendents of the Austin State School - Philip Roos, Bill J. Doggett, Larry Talkington, and Billy R. Walker - and one acting superintendent, Victor Hinojosa. To them and to their staffs we owe much thanks for providing us with the facilities and cooperation which made our work possible. Walton Pennell, the School's business manager, and his staff have very capably coped with the disarray we produced by changing plans already under way, failing to meet deadlines, and keeping incomplete records.

The children used as subjects in this project were almost all residents at the Austin State School. We often interrupted schoolrooms and dormitories to obtain the child needed at a particular time. To the principals - Margaret Oliver and Jane Duckett - and the teachers of the school, and to the dormitory personnel, we offer our thanks for their understanding and cooperation. Subjects were also obtained from the Travis State School in Austin, Texas, the Denton State School in Denton, Texas, and the special education classes of the Austin Independent School District; we are grateful to the superintendents, principals, and teachers of the first two, and to the central staff and teachers of the third, for their willingness to allow their pupils to participate in the research.

Most of the actual labor of experimentation was done by a group of capable, efficient research assistants. For many hours of hard work well done, we thank Robert Conrad, Mike Farmer, Stuart Frager, Peggy Goulding, Dan Morris, and Janee Sweeney. Two of these are due special mention: Dan Morris built a device similar to the Wisconsin General Test Apparatus and prepared programs for the MTA Scholar, and Stuart Frager made the slides used as stimuli in the applied study. Jewel Fleming prepared the stimuli used in several of the experiments and helped to calm and entertain subjects while they were waiting to participate; to her, too, we are very grateful.

Three men have served as idea generators and/or idea evaluators at various stages of the project. James Hawker wrote the original proposal on which the project was based. Robert Young gave advice on statistical analyses. Walter Stolz, who shared an office with one or the other of us throughout the project, served as a sounding board when research questions were being decided; his collaboration at some points approached that of a co-author. All three of these deserve much thanks for their help.

Since both of us had left the Austin State School before this Final Report was completed, we especially appreciate the help of Nicky Neal in shepherding it through the details of preparation and printing.

Sandra Merryman
Sue Seitz

Contents

Chapter 1: Previous Research

Skinner's position (1954, 1958) that error-rate should be kept at a minimum during guided learning has generated an increase of interest and research in an area which had been generally neglected since 1930. At that time Carr's review of the literature concluded with the observation that the effectiveness of guidance depends on many other task variables, including the amount of guidance, the point at which it is introduced, and the particular type of task.

Current research continues to indicate support for Carr's conclusion. Guided or prompted learning (P), in which the subject (S) is shown the correct response to each stimulus before he responds, so that his probability of error is reduced to near zero, has been compared with confirmation (C) or trial-and-error learning, in which the S is permitted to respond without guidance and is then told whether he made the correct response. When adult Ss were used, some researchers found that P resulted in better performance (Angell and Lumsdaine, 1960; Battig & Brackett, 1961; Cook, 1958; Cook & Kendler, 1956; Cook & Spitzer, 1960; Irion & Briggs, 1957; Kopstein & Roshal, 1955; Levine, 1965; Moursund & Chape, 1966; Peterson & Brewer, 1963; Sidowski, Kopstein, & Shillestad, 1961; Sidowski & Green, 1968). Others found no difference between P and C (Cofer, Obsen, & Walker, 1965; Hawker, 1964b; 1965a; 1965b; 1967; Lockhead, 1962; Silberman, Malaragno, & Coulson, 1961). And Hawker, in two studies (1964a, 1964c), found C more effective.

Although the results of research with adult Ss are inconsistent, there is some support for Carr's (1930) conclusion that the effectiveness of a particular method may depend on the type of task involved. There is also some evidence that any superiority of P may be found only early in learning (Hawker, 1964b; 1965b; Peterson & Brewer, 1963).

The implications of errorless learning for applied research with retarded children resulted in several studies dealing with sight vocabulary learning. Stolorow (1961) found that with a lax criterion, there was no difference in the effectiveness of P and C; however, with a more stringent criterion, P produced greater performance. Stolorow & Lippert (1962) found that P was superior to C in acquisition, but that C led to better retention at tests seven and 30 days after original learning. Blackman and Holden (1963) found no differences between P and C in either acquisition or 24-hour retention. Hawker, Geertz, and Shrago (1964) and Hawker (1966a) found no difference in P and C for trainable and educable mental retardates, respectively. These differing results appear to depend in part on the criterion used and on whether original learning or retention of sight vocabulary is used as a measure.

There have also been a few studies with traditional verbal learning tasks and mentally retarded children. When educable Ss learned a paired

associate (PA) list, C produced better retention, as measured by re-learning after one week, but was not different from P in original learning (Hawker & Keilman, 1966). Returning to the idea that the type of task can interact with training procedure, Hawker (1966b) compared P and C in a series of three discrimination tasks. Although different materials (pictures and words, two and four response alternatives) and both educable and trainable Ss were used, P always produced significantly better learning. Similar results have been reported with an object-discrimination task (Fletcher, 1965; Fletcher, Davis, Orr, and Ross, 1965).

The above research illustrates differences which could be ascribed to the type of task (PA or discrimination), the type of S (normal adults or retarded children), and the performance measure taken (original learning or retention). While some of the differences are no doubt due to these three factors, enough inconsistencies remain when these factors are held constant to suggest that other methodological variables are operating. Several variables which are suggested by current work in learning, memory, and verbal behavior were investigated in the studies reported in Chapter 2.

Chapter 2: Paradigmatic Studies

The project reported here was conceived with the notion that the most effective training procedure for retarded Ss might be predicted for specific types of tasks if the variables interacting with training procedures could be determined. Accordingly, a series of parametric studies was carried out, each study investigating a specific factor which might differentially affect learning by P and C.

Since these studies have previously been reported, they will not be given in full detail here. Rather, an abbreviated discussion of the problem, method, and results will be presented. The reader is referred to the original report of each of the experiments for detailed reports of the methodology and results; in each case, the original paper will be cited.

All these experiments used as Ss mentally retarded children, with both IQ and chronological age (CA) equated across conditions. Mean IQs and CAs for the samples used in each experiment are listed in Table 1. The Wechsler Intelligence Scale for Children (WISC) was the primary instrument for IQ assessment. Except where otherwise stated, the Ss were residents of the Austin State School.

Because of the difficulty of recall for these Ss, recognition measures were taken. In PA learning, the S was shown a stimulus at test and asked to choose the correct response from three or four possible responses, all of which were correct for some stimulus. In discrimination learning, the S was simply asked to choose a correct response from a group including one correct item and two or three incorrect ones.

Again, because of the greater ease of obtaining recognition rather than recall responses from these Ss, the C procedure used in all the studies consisted of presenting a multiple-choice array (the stimulus and several possible responses in PA tasks, a correct item among incorrect items in discrimination tasks) to the S, obtaining a spoken, pointing, or button-push response from him, and then (usually) presenting a duplicate of the multiple-choice array, this time with the correct response underlined. (In some experiments, the S responded repeatedly in the C procedure until he gave the correct response.) The P procedure omitted the first array and reversed the order of the other two events. That is, in P, the S saw the multiple-choice array with the correct response underlined and was required to indicate the correct response, by speaking, pointing, or pushing a button. Non-feedback tests were usually interspersed among the training trials; these tests consisted of presenting a multiple-choice array without underlining to the S who then responded but was not told whether his response was correct or what the correct response was.

In all the parametric studies to be reviewed below, effects which are mentioned as occurring were statistically significant at or beyond the 5% level.

Experiment 1 (Seitz, 1969a)

In this initial comparison of P and C, it was observed that in the P condition, test trials are distinctive from learning trials in that the correct word is always underlined on the reinforced trial. In one form of the C procedure, however - the procedure in which the S responds repeatedly until he responds correctly - test trials and learning trials are alike in appearance. In the test situation any response may serve to advance the program, just as a correct response served to advance the program (and give feedback thereby) during the practice trials. It seemed that in the C condition one important source of incorrect associations could be eliminated by deleting all interspersed test trials. The practice trials could serve as test trials also if the first choice were scored.

With a discrimination learning task, C was compared under three conditions: 1) practice trials with interspersed test trials; 2) practice trials verbally reinforced by the experimenter (E) plus interspersed test trials; 3) practice trials verbally reinforced by E but no interspersed test trials. Stimulus arrays were automatically presented on an MTA-SR 400 Scholar. Performance was significantly superior in the third condition. Unfortunately, this study clearly shows the difficulty of direct laboratory comparison of P and C in discrimination tasks, since performance under C is optimal without interspersed test trials, which must always be a part of a P procedure.

Experiment 2 (Seitz and Sweeney, 1969)

The possibility that interspersed tests might not have the same effect in PA learning as in discrimination was indicated by Izawa (1968), who found confirmation PA learning better with interspersed tests than without. Seitz and Sweeney followed Izawa's design but used retarded Ss and added the P procedure for comparison. Ss were instructed to learn eight pairs of pictures presented by a slide projector. There were four groups in both the P and C conditions. For each group, each block of practice trials was followed by one of the following: two blocks of neutral trials; two blocks of test trials, one block of test trials, or no intervening material. On a neutral trial, the S merely looked at a slide bearing a geometric figure, without responding. Overall, there was no significant difference between performance in the P and C conditions, but there were significant differences attributable to the presence and type of interspersed trials in the C condition. Inclusion of two blocks of test trials between blocks of practice trials significantly improved performance over the other C conditions. Fewest errors were committed by Ss in the P condition where practice trials were followed by two blocks of eight neutral slides. This was significantly better than the worst performance, given by the C group which received no interspersed trials. Inclusion of test trials did not improve performance in the P condition, however.

Thus, it would seem that interspersed test or neutral trials may be one variable interacting with P and C and with the type of task. Whereas the overall variance attributable to the P and C procedures in the PA task does not show any difference in their effectiveness, the introduction of

neutral trials in the P condition or the removal of interspersed materials in the C condition results in significantly different performances.

Experiment 3 (Seitz, 1969b)

The interspersed trials effects suggested that other manipulations affecting the duration of a trial, the time between the presentation of the stimulus and its recall, and the intervention of any material in that interlude could also affect learning. The effects of stimulus presentation rate has been shown to be a factor in the performance of dull Ss by Galligos (1966) and by Gordon, Gordon, & Perrier (1967). Post-response stimulus duration (Ellis and Anders, 1968) has also been demonstrated to be a powerful factor in the performance of retarded Ss.

It was hypothesized, therefore, that retarded Ss would perform a discrimination task best if the task were automatically paced at a rate slower than that at which these Ss would pace themselves. To allow uniform timing of presentation in the E-paced conditions, a P procedure was used. In a three-choice letter or number discrimination task presented on an MTA-SR 400 Scholar, self-paced Ss were found to respond within a mean of 2 sec. after stimulus presentation. When the presentation of materials was automated and slowed to 4 sec., learning was significantly improved. Automated presentation at a 2-sec. rate did not result in performance different from that of the self-paced group.

Experiment 4 (Seitz and Morris, 1969)

Still another aspect of presentation rate was investigated in a partial replication of the Peterson and Peterson (1959) short-term retention study. The variable under investigation here was the duration of the interval between the presentation of the stimulus and the signal for its recall (the retention interval).

The stimul were 32 three-letter words. During the retention interval Ss were required to read aloud a series of random numbers. Both the words and the numbers were presented on an MTA-SR 400 Scholar. The task was divided into four blocks of eight trials. In the first block, the retention interval was 3 sec. and the retention interval number-reading task was omitted. This first block of trials served as practice. The remaining blocks of trials included number reading. Half the Ss had retention intervals of 3, 9, and 18 sec., respectively, in the last three blocks; this sequence was reversed for the other Ss. In addition, half the Ss receiving each sequence were instructed to say the stimulus words aloud; the other half of the Ss were asked to think the stimuli silently.

Retention of the stimuli was significantly greater both 1) when the stimuli were read aloud and 2) when the sequence of retention interval blocks was 18 sec., 9 sec., 3 sec. There also was a significant interaction, the effect of vocalization being greater in the order 3, 9, 18 sec. than in the order 18, 9, 3 sec. Perhaps vocalization of the stimuli increased the probability of their transfer into long-term store (Atkinson & Shiffrin, 1968) because of either the extra repetition of the item or because of repetition of the item in a second modality. The sequence effect, however, would result from a set to retain the items longer in

the 18, 9, 3 sec. sequence; Ss with this set might, without instructions, use whatever rehearsal strategies where necessary to transfer the stimuli into long-term store. Therefore the effect of vocalization would be greater in the sequence which did not produce a set for long retention.

Experiment 5 (Seitz and Farmer, 1969)

Although most discrimination studies reviewed had showed P to be the more effective procedure, the Seitz (1969a) data, indicating an improvement in C performance when interspersed trials were omitted, suggested another comparison of P and C. Perhaps, with all interspersed test trials omitted for both the P and C conditions, no difference in performance would be seen. The disadvantage, of course, is that one cannot measure number of trials to criterion. Nevertheless, it is possible to measure performance after a given number of trials. Seitz and Farmer used a three-choice discrimination task with simple geometric figures as stimuli. Subjects were 32 educable retardates from the Austin State School and 32 children from a comparable IQ and CA range drawn from the Austin Public Schools special education classes. All Ss were classified as cultural-familial retardates. Inclusion of the latter Ss allowed an investigation of the interaction of institutionalization with P and C.

Eight sets of three simple geometric figures were presented either automatically on an MTA-SR 400 Scholar or by E on flashcards, and the Ss' task was to select the correct figure from each set of three. Each S received 15 practice trials through the list. Non-feedback test trials were given immediately following practice, 30 minutes later, and 24 hours later. All Ss were tested at all three intervals. Both institutionalized (I) and non-institutionalized (NI) Ss were randomly assigned to one of four conditions: prompting-machine presentation (PM); prompting - E presentation (PE); confirmation - machine presentation (CM); and confirmation - E presentation (CE).

Separate analyses of variance of error scores were performed for the I and NI groups. No significant treatment effects were found for the I group, who made significantly fewer errors overall than did the NI Ss. For the NI group, however, there were significant differences attributable to the method of learning, type of presentation, and the interaction of these two variables. For the NI Ss, C produced significantly fewer errors, as did the flashcard presentation of materials. A significant interaction showed fewer errors committed under C when the flashcard method of presentation was used, and fewer errors under P when machine presentation was used. An orthogonal comparison of the CE group across retention intervals showed a significant linear trend of improved performance.

The prediction that P and C would result in equivalent performance when test trials were omitted was confirmed in the I group. Hawker's (1966b) finding that I retardates performed better in a verbal discrimination task under P than under C was most likely due to his inclusion of interspersed test trials and the resulting decrement of performance in the C condition (Seitz, 1969a).

The performance of the NI Ss did not accord with that of the I sample. However, it is likely that the NI results were due more to motivational

factors than to the direct influence of the P and C methods of presentation. According to Zigler (1969):

> The self-initiated solutions of the retarded would be expected to result in a high incidence of failure, thus making the retarded wary of the solutions provided by their own thought processes. This type of child should then evidence a greater sensitivity to external or environmental cues...than would normal children. The institutionalized retarded live in an environment adjusted to their intellectual shortcomings and should, therefore, experience less failure than the noninstitutionalized retarded. This latter type of child must continue to face the complexities and demands of an environment with which he is ill-equipped to deal and should, as we found, manifest the greatest sensitivity to external cues.

Work directly supporting this interpretation, and predictive of the difference in performance of our NI Ss under P and C, was reported by Achenbach and Zigler (1968):

> ..the retarded [Ss] relied on the cue significantly longer than the normals. Furthermore, the noninstitutionalized retarded relied on the cue significantly longer than the institutionalized retarded....A replication also demonstrated that reliance on the cue by the retarded involved an inhibition of learning rather than caution in responding.

The results for our NI Ss in the PE condition are consistent with the pattern noted by Achenbach and Zigler. These Ss apparently attended to the cue rather than to the stimulus. (The poor performance of NI Ss in both P and C conditions on the MTA Scholar should be discounted, for it is probably attributable to inexperience with the equipment. In addition, performance would be hindered in these outer-directed NI Ss simply by the demand characteristics of the 10 control buttons on the MTA Scholar.)

The NI CE Ss, who made few errors on the immediate test, improved their performance on the test 0.5 and 24 hours later. This reversal of the expected forgetting follows from the observation that retarded Ss new to the experimental setting must learn that the experimenter is not to be feared. In this study, the institutionalized Ss had had experience with the experimental setting, the E, and the rewards for cooperation, and thus were eager to participate. The NI Ss, on the other hand, could be expected to approach the E with a history of nonrewarding (failure) contacts with adults. Each session with E should serve to reduce the NI Ss' fear of the experimental setting and thus to increase their performance across subsequent tests.

Experiment 6 (Farmer and Seitz, 1969)

Since motivational factors seemed to be a powerful determinant in

the performance of institutionalized and noninstitutionalized Ss, it seemed worthwhile to extend the comparison to the trainable level S. The comparison was especially appealing since several investigators, notably Harter (1967) and McGunigle (1968) have demonstrated that preference for abstract rewards is highly and independently correlated with both MA and IQ in normal and retarded children. Therefore social reinforcement, and thus presentation of stimuli by a social agent, might not be as motivating for trainable level Ss.

Thirty-two trainable (IQ range 30-50) residents of the Travis State School served as Ss, eight in each of the four conditions of the Seitz and Farmer study above. Only institutionalized Ss were used, since there were no trainable retardates of comparable CA in the public schools. The Seitz & Farmer educable I Ss had a mean MA of 8.91 years and a mean CA of 15.33 years; the new trainable group had a mean MA of 5.23 years and a mean CA of 14.53 years. It was expected that the educable Ss would produce a significantly higher level of performance, and a lower rate of forgetting. As was stated above, neither condition of learning (P or C), mode of presentation (machine or flashcard), or length of retention interval (0, 0.5, or 24 hours) differentially affected performance of the educable I Ss. However, since trainable institutionalized retardates may share with noninstitutionalized educables a history of failures, these variables might well affect the performance of the trainables.

For the trainable group of Ss, C produced significantly fewer errors, as did the machine method of presentation. The interaction showed fewer errors under P when machine presentation was used and fewer errors under C when E presentation was used. There was also a significant decrement in performance across time. A comparison of total error scores for these trainable Ss and the Seitz and Farmer I educable Ss showed significantly fewer errors for the educable sample.

Inspection of the error scores indicated that the major source of variance in the trainable sample was the PE condition. The remaining conditions were not markedly different in initial performance (test immediately after training) from the educable sample. These findings led to a series of ad hoc comparisons. In the PE condition alone, the educable Ss made fewer errors than the trainable Ss. The PE condition represented the best and worst performance for the educable and trainable groups, respectively. However, discounting the PE conditions in both samples, these experimental conditions permitted equivalent performance on the first test of a simple discrimination learning task by children at two widely different MA and IQ levels.

It is not clear what factors might account for the Farmer & Seitz results. However, it is interesting to note that the interaction of P and C with type of presentation was similar for the trainable Ss and for Seitz & Farmer's NI educable Ss. Both groups were unfamiliar with the E and with experimenters in general. Thus it is plausible that both the NI Ss and the I trainable Ss performed as they did for motivational reasons, rather than because of differential learning, per se, produced by the various conditions.

Experiment 7 (Seitz and Merryman, 1970)

One possible consequence of the C procedure in PA learning is an at-

tempt on S's part to find a mediator between the two members of a pair. P training, on the other hand, may reduce efforts to mediate, since the S is told the correct answer at the beginning of each study trial, and thus it may focus S's attention on the members of the pair themselves. If such a difference in the elicitation of mediation does exist, a task in which mediation would slow learning should be learned more readily by P than by C training.

Underwood and Schultz (1961) found that one of the most difficult types of PA lists is that in which the members of one category are paired with the members of a second category. Underwood (1966) hypothesized that the difficulty of such a list arises from S's attempts to use category names learned prior to the experiment as mediators in the PA task. Since the same category names could mediate between the members of all the pairs, such mediation should produce intra-list confusions and the obtained longer learning time.

The hypotheses that P reduces mediation was tested using eight pairs in which the stimuli were all names of animals and the responses were all names of foods. Residents of the Austin State School and the Denton State School learned both a category X member-category Y member list constructed as above and a PA list composed of pairs in which no two of the stimuli or responses belong to a single category.

Sixteen of the Ss learned both lists by P with interspersed test trials, sixteen by C with interspersed test trials, and sixteen by C without separate test trials. Comparison of the latter two groups was desired to confirm the Seitz & Sweeney (1969) finding that the inclusion of non-feed-back test trials increases learning of a PA list.

The Seitz & Sweeney test trials result and Underwood & Schultz category interference result were replicated. Those Ss who did not have interspersed test trials made fewer correct responses across twelve trials than the other two groups; performance under P and C, where both included separate test trials, was equal. More correct responses were made on the list composed of words from various categories than on the list composed of stimuli from a single category and responses from a second single category.

The hypothesis that P would reduce the incidence of mediation and thus the difficulty of the category X member-category Y member list was substantiated. When training was by C, regardless of whether separate tests were included, performance was better on the list composed of dissimilar items than on the list composed of words from only two categories. However, when training was by P, performance was equivalent on the two lists. That is, the list which should have profited from mediation was learned less well under P, while the list that should have suffered interference from mediation was learned better under P.

Experiment 8 (Merryman, Frager, and Seitz, 1970)

The mediation most likely occurring in the above study arose from pre-experimental learning and produced, for one of the lists, intra-list interference. Merryman, Frager, & Seitz (1970) tested whether

inter-list interference arising from learning within the experimental session could be reduced by a P procedure in the second list. The Ss learned two 6-pair PA lists in either the A-B, A-B' or the A-B, A-B'r paradigm. (In the A-B, A-B' paradigm, the same stimuli were used in two lists, and the two responses paired with each stimulus were similar to each other in some way. Rearrangement of the pairings in the second list yielded the A-B, A-B'r paradigm.) Both members of each pair were pictures of common objects, and the B and B' pictures were chosen so that the name of each B' item was a high associate to the name of one and only one of the B items. For each S, half of the first list was learned by P and half, by C. The second list was learned by a single method, half the Ss learning it by P and half, by C.

The second list in the A-B, A-B' paradigm was learned with fewer errors than the second list in the A-B, A-B'r list. However, method of training on either the first or the second list did not interact with paradigm. Therefore the hypothesis that P training would reduce mediation between lists learned within a single experimental session, and thus reduce the negative transfer in A-B, A-B'r paradigm, was not upheld. The discrepancy between this result and the earlier Seitz & Merryman finding may be due either to a difference between intra- and inter-list interference or to a difference between highly overlearned responses gained outside the laboratory and marginally learned responses gained in the laboratory experimentation. The two are confounded in the present comparison.

There was, however, an interaction found between methods of training on the two lists, regardless of paradigm. Performance was better on the second list when the two lists were learned by different methods than when the two were learned by the same method. That is, for List 1 items learned by P, the corresponding List 2 items were learned with far fewer errors under C than under P; and for List 1 items learned by C, there was faster learning of the corresponding List 2 items under P than under C. Thus it appears that method of training, for these Ss, served as a cue for storage and retrieval of the desired association. Items stored under the same training procedure have one more momory "tag" (Bower, 1967) in common than do items stored under different training procedures. It follows that items learned by the same procedure, whether P or C, interfere with each other during learning of the second list and, one might suppose, during attempted retrieval of the items following some retention interval. The interference produced by learning method appears to act independently of specific interference operating differentially in the A-B, A-B' and A-B, A-B'r paradigms.

SUMMARY

As had been expected, the paradigmatic studies cited above failed to indicate a clear superiority of either P or C. However, these studies can be summarized in terms of several factors which were found to affect PA and discrimination learning. Some of these factors were found to interact with the P and C training conditions.

1. Intervening tests. In PA learning, inclusion of nonreinforced test trials within a C procedure improved performance; nonreinforced test trials did not affect performance within a P procedure. In discrimination

learning, however, nonreinforced test trials decreased performance within a C procedure. (Experiments 1 and 2)

2. Environmental status of Ss and their consequent expectancy of success or failure. Institutionalized educable retardates performed equally well under P and C in a discrimination task. Noninstitutionalized educables, on the other hand, performed better under C than under P. The discrepancy is likely due to the varying opportunities for success in the environments of the two groups. Institutionalized retardates, whose environment is structured to match their abilities, should come to the experimental situation with a relatively high expectancy of success. Their noninstitutionalized peers, however, should approach the experiment with a greater expectancy of failure. The C procedure offers opportunity for S-chosen responses to be confirmed, an experience which may increase expectancy of success more than does S's repetition of E-chosen responses in the P procedure.

Institutionalized trainable retardates, like the noninstitutionalized educables, performed the discrimination task better in the C procedure. It is hypothesized that even their fairly structured environment does not afford the less-able trainables many opportunities for success. Thus, the trainables entered the experiment with an expectancy of failure which was reduced more by the C than by the P procedure. (Experiments 5 and 6)

3. Rate of presentation. In a discrimination task employing a P procedure, performance was best at a presentation rate slower than that at which Ss paced themselves. The increased performance was likely due to the longer post-response interval (allowing for increased rehearsal) concomitant with slower presentation rate. (Experiment 3)

4. Time between stimulus and response. Subjects who were presented short-term memory trials so that trials with long retention intervals preceded trials with short retention intervals remembered the stimuli better than Ss who recrived trials increasing in length of retention intervals. Presumably Ss receiving the longer trials first formed a set to remember the stimuli longer. (Experiment 4)

5. Interference. Intra-list interference in a PA task was reduced when training was by P rather than C. However, inter-list interference was equally potent within both training procedures. (Experiments 7 and 8)

6. List differentiation. Regardless of the degree of similarity between two PA lists, the second list was learned with fewer errors when different training procedures (P and C) were used for the two lists than when both lists were learned by the same procedure. (Experiment 8)

Chapter 3: Applied Study

The paradigmatic studies reviewed in Chapter 2 did not indicate a general superiority of either P or C. However, it is possible that longer-term learning such as that occurring in the classroom, where a given concept may be learned over a period of several weeks or months, consists of different processes than the relatively easy learning occurring in one laboratory session.

Accordingly, it was decided to attempt the teaching of some academic task to several mentally retarded Ss, such teaching to proceed for about three months. The time limit was imposed by the fact that many of the Ss would not be available during spring and summer vacations. Thus, a relatively simple type of learning was desired. Most of the prospective Ss were interested in learning arithmetic, since they were ocassionally cheated out of their money by older residents. In addition, the school was eager for these students to learn arithmetic skills; a good deal of school time was spent on the teaching of arithmetic, but with only limited success.

Few of the Ss could do even very simple sums, most could not specify how many objects were present (they might say "three" or "eight" when, in fact, six pennies were offered them), and a few of the Ss could not reliably give the names of the digits. Their schoolteachers, however, judged them capable of learning these number skills at some point in their training. Therefore the applied learning tasks in which P and C were assessed consisted of labeling the digits 1 through 10 with their names, matching the numbers one through ten with sets of objects, and adding all the pairs of numbers that sum to ten or less.

It seemed likely that some combination of P and C might prove more effective than either separately. For example, early in learning when Ss might be expected to make many errors, P might prove better because it would keep the Ss from practicing and thus learning incorrect responses. However, since the end behavior desired from the training program is the ability to correctly specify the number of objects in a set and the sums of two numbers, trials late in learning perhaps should include the possibility for errors so that remaining misconceptions could become apparent and be corrected. In addition, previous work by Stolorow and Lippert (1964), in which methods of teaching sight vocabulary were investigated, indicated that P followed by C led to the greatest retention.

Accordingly, one of the training procedures investigated in the applied study was P followed by C. For comparison purposes, C followed by P and the alternation of P and C were included. Thus, there were five procedures in the study; all P, all C, P followed by C, C followed by P, and alternation of P and C.

Method

Materials. The task of moving from no number knowledge to the ability to add numbers summing to ten or less was broken into seven stages. The first, Stage Pre-1, required the Ss to learn the English names for the digits 1-10. Materials for Stage Pre-1 were 5" X 8" white flashcards, each with a large digit written on it in black ink.

In the other six stages 35 mm color slides were used. [When ever possible, pictures of coins were used for training, since these children pay more attention to money than to almost anything else.] Stages 1, 2, and 3 required Ss to match pictures of sets of objects with the digit specifying the size of the set. In Stage 1, the stimulus set at the top center of the white slide was made up of pennies. At the bottom of the slide, there were three groups of pennies, one of them containing the same number as the stimulus set; under each group of pennies at the bottom of the slide was a digit indicating the number of pennies in that group. The pennies in the correct response set were always arranged identically to the pennies in the stimulus set. In Stage 2, a black background was used and the stimuli were sugar cubes. The sets of sugar cubes and their respective digits were positioned on the slide as the sets of pennies were in Stage 1, with the exception that the correct response set in Stage 2 had the sugar cubes arranged in a different pattern than those in the stimulus set. In Stage 3, dimes on a black background were used. A group of dimes made up the stimulus set at the top center, but the response alternatives were digits only; no dimes appeared at the bottom of the slide.

Stages 4, 5, and 6 required the Ss to add two sets of objects and/or to add two digits. In Stage 4, the materials were small green blocks on a white background. At the top of each slide there were two sets of blocks, each with a digit under it indicating the size of the set; between the digits was a plus sign. At the bottom of the slide there were three sets of blocks, each with the appropriate digit beneath it; one of those sets contained as many blocks as the two sets at the top combined. The slides for Stage 5 used dimes which had been painted red, on a white background. The construction of the slides was as in Stage 4 except that the response alternatives at the bottom of each slide were digits only, without objects above them. In Stage 6, both the stimulus at the top of the slide and the response alternatives at the bottom consisted of digits only. Thus, "5 + 3" might appear at the top of a slide, with "4", "9", and "8" at the bottom.

Three slides for each stimulus and its correct alternative were prepared in each stage. Stages 4, 5, and 6 required three slides for a + b and three for b + a. Since two incorrect responses alternatives appeared on each slide, there were six incorrect alternatives for each set of three slides with the same stimulus. The alternatives were drawn from the set of numbers one through ten so that each number was used equally often as an incorrect alternative within a given stage. Also, for each pair of slide sets with the same addends in Stages 4, 5, and 6 (e.g., 2+3 and 3+2), each of the nine incorrect alternatives was used at least once. Within the three slides for each stimulus, the correct response alternative was presented once on the left, once in the middle, and once on the right. Each slide constructed as above was made twice, once with and once without a line under the correct alternative.

Subjects. Thirty-two residents at the Austin State School served as Ss. Their CAs and IQs are listed in Table 2. Mean CA for the group was 11 years, 8 months; Mean IQ was 49.8. All Ss were enrolled in the School's educable program at the equivalent of the nursery school, kindegerten, or first grade level. In order to determine where each S should begin the program, a pre-test was administered. The pre-test consisted of naming each digit as the flashcard bearing it was presented, and selecting a response to each of three slides from each of Stages 1-6. Each S entered the program one stage below the point at which he failed to perform perfectly on the pre-test, unless he missed some items in Stage Pre-1; in that case, he entered the program at Stage Pre-1. Since the Ss varied in their abilities and their previous arithmetic learning, and since differences among training procedures rather than among Ss were of interest, all treatments within a given stage were administered to each S. The pairing of stimuli and treatments was counterbalanced across Ss. Of the 32 Ss, 25 were run in the study two or three times a week, for approximately 30 min. at a time, over a period of approximately three months. (The number of sessions varied across Ss because of visits home, field trips, illness, etc.) Seven of the Ss were run four or five times a week, again for approximately 30 min. at a time, for only a few weeks in the summer. These latter Ss were run in order to fill out the counterbalancing for particular stages; they were terminated as soon as they reached criterion in the stage for which data were needed. In addition, three other Ss were begun in the study, but their data are not included in the analysis. Two of these were discarded because they failed to make more than two errors in any stage of the program; one of these Ss, in fact, never made an error! (No S is included in the analysis of any stage for which he made fewer than five errors.) Whether these two Ss learned each stage in the two practice trials before the first test or whether they knew the material of the entire program before training began is not known. The other S was discarded because she refused, early in the program, before reaching criterion in her first stage, to return to the experiment.

Procedure. There were five methods of training: 1) entirely by prompting (P); 2) entirely by confirmation (C); 3) prompting for 12 practice trials in Stage Pre-1, six practice trials in Stages 1, 2, and 3, or four practice trials in Stages 4, 5, and 6, followed by confirmation thereafter (P-C); 4) confirmation for 12 practice trials in Stage Pre-1, six practice trials in Stages 1, 2, and 3, or four practice trials in Stages 4, 5, and 6, followed by prompting thereafter (P-C); and 5) alternate trials by the two methods, with practice trials 1, 3, 5, . . . by prompting and practice trials 2, 4, 6, . . . by confirmation (Alt). A test trial without feedback followed every second practice trial. In each series of two practice trials and one test trial, all three slides for each stimulus were used, the assignment of slide to trial within that series being random. The order of stimuli within a trial was also randomized. Within a single session, only one series of two practice trials and one test trial was prepared in Stages 1-6; that series was repeated enough times to fill the 30 min. session and end with a test trial. In Stage Pre-1, the flashcards were shuffled by hand before every practice or test trial.

In Stage Pre-1, a prompted practice trial consisted of E's holding up a card and saying aloud the name of the digit. The S then repeated the name. A confirmation trial consisted of E's holding up a card, S's

saying what he thought the name of the digit was, E's then saying the correct name of the digit, and S's repeating the correct name. On test trials, E held up the card and S responded, but E did not give the correct response or comment on the correctness of S's response. In all other stages, a prompted trial consisted of presentation of a slide with the correct alternative underlined and S's saying and pointing to the number which was the correct alternative. On confirmation trials, a slide without underlining was presented, S pointed to and said one of the response alternatives; the slide with the correct response underlined, but identical to the previous slide in every other way, was shown; and S pointed to and said the correct response. Test trials involved presentation of slides without underlining and S's responses to them; the S was not told whether his responses were correct. Presentation of the flashcards and slides was S-paced, except that the card, or the last slide within the trial, was left exposed for an additional 2 sec. after the last overt event of the trial (on both practice and test trials).

Within each stage, the stimuli were divided into five groups and, for a given S, each group of stimuli was assigned to a particular treatment. Thus method of training was a completely within-S variable, and assignment of method to stimulus group was counterbalanced across Ss. In Stages Pre-1, 1, 2, and 3, the five groups of stimuli were 1 and 10, 2 and 9, 3 and 8, 4 and 7, and 5 and 6. In the addition stages (4, 5, and 6), the large number of stimuli required that these stages be broken into two parts; when all the stimuli in the first part of a stage had been learned, they were set aside and training was begun on the second part of that stage. For Stages 4A, 5A, and 6A, the groupings of stimuli were a) 1+2, 2+1, 2+4, 4+2; b) 1+3, 3+1, 2+3, 3+2; c) 1+4, 4+1, 1+9, 9+1; d) 1+5, 5+1, 1+8, 8+1; e) 1+6, 6+1, 1+7, 7+1. For Stages 4B, 5B, and 6B, the five groups of stimuli were a) 1+1, 2+5, 5+2, 4+6, 6+4; b) 2+2, 2+6, 6+2, 4+5, 5+4; c) 3+3, 2+7, 7+2, 3+7, 7+3; d) 4+4, 2+8, 8+2, 3+6, 6+3; e) 5+5, 3+4, 4+3, 3+5, 5+3.

The Ss were run in each stage or part of a stage, except Stage Pre-1, to a criterion of at least one perfect test in each of two consecutive sessions. In Stage Pre-1, the criterion was at least two perfect tests in each of two consecutive sessions. After the S completed both parts of an addition stage (e.g., 4A and 4B), he was tested over both parts combined. Had there been any errors, he would have been required to re-learn that part of the stage from which the errors arose until he again met the criterion on that part and could perform perfectly on a re-test of both parts combined. However, none of those few Ss who succeeded in learning one or more of Stages 4, 5, and 6 missed any items on the first test for the combined stimuli of the entire stage.

It was hoped that the Ss would desire to participate in the study for its own sake and because of the attention they received from the Es. Informal observation seemed to confirm this hope. However, in recognition of the potential boredom which could develop over the weeks and months of the study, extrinsic rewards were also used. A supply of such things as yo-yos, jacks, noise-makers, pencils, construction paper, chewing gum, and candy was maintained. An attempt was made to have a variety of objects which the Ss had told us they liked but which averaged only five cents each in cost. Each S, upon arriving for the experiment, selected his gift for the day; the reward was then placed in the S's sight but out of his reach. It was given to the S at the end of the session. In addition, Ss were

rewarded for completing a stage or set of stages (depending on a given S's speed of completion) by being taken out for a hamburger lunch. The opportunity to leave the campus for a short time proved to be a powerful incentive; most of the Ss worked quite hard to obtain their lunches.

The instructions for each stage varied in the description of the materials and S's task, but were quite similar across stages. Sample instructions are given in the Appendix.

Results and Discussion

The disparate achievement levels of the Ss when they entered the program and the different speeds with which Ss moved through the program resulted in more Ss being run in some stages than in others. The stages at which Ss entered and left the program are given in Table 2. Several Ss performed perfectly or near perfectly in one or more stages between their first and last stages. (Skipping of stages usually occurred when Ss learned more than the minimum requirements for success in a given stage; e.g., several Ss could perform correctly on the first trial of Stage 2, apparently because they had used set size, rather than arrangement of the stimuli, as their cue for responding in Stage 1.) In all, data from 15 Ss were analyzed in Stage Pre-1, 11 in Stage 1, 13 in Stage 2, 11 in Stage 3, and 10 in Stages 4A and 4B. Only three Ss both reached Stages 5 and 6 and made errors in them--too few Ss to allow for analysis.

The incomplete overlap between Ss in the various stages, also resulting from Ss' unequal abilities and past learning, severely constrained the kind of analysis which could be done on the data. It was not possible to analyze the results over the program as a whole or over any parts of the program larger than a single stage.

In each stage, the Ss were run to criterion, rather than for a fixed number of trials. Use of number of errors as a measure of learning would, under these conditions, add unnecessary variability to the scores, since the errors of one slow learner could effectively mask the errors of several fast learners. Therefore, for each S, the number of opportunities for errors on items presented by a given method within a given stage (number of test trials times number of items presented by that method) was divided into the number of errors for that presentation method. This division yielded the percentage of opportunities for errors on which errors were made, for each method. The mean percentages of errors under each training method, for Stages Pre-1 through 4B, are presented in Table 3. The percentage of errors under the five methods were submitted to a separate analysis of variance for each stage, with training method and counterbalancing group (assignment of items to methods) as factors. In stages where the number of Ss run was not a multiple of five, Ss were randomly dropped from those counterbalancing groups having more Ss.

As could be surmised from Table 3, the analyses of variance detected no significant differences among training methods within any stage ($fs<1$ in every case). There were, however, a few significant effects. In Stages Pre-1, 2, and 4A, the interaction of training method and counterbalancing group was significant ($F = 2.54$, $df = 16, 40$, $p<.01$; $F = 2.64$, $df = 16, 20$, $p<.05$; and $F = 1.99$, $df = 16, 20$, $p<.10$ respectively). In addition, there

was a significant difference among the counterbalancing groups in Stage 4A ($F = 8.00$, $df = 4, 5$, $p < .05$). Since six analyses of variance were performed, it would not be unexpected to find a few statistically significant effects merely by chance. Thus, these few significant results might have been dismissed had it not been for the surprising counterbalancing groups main effect in Stage 4A. Examination of that effect led into a comparison among Ss and stages across the program.

The division of Ss into five groups in order to counterbalance the assignment of stimuli to training methods resulted in a confounding of S ability with stimulus-method pairings. Therefore the interaction of method with counterbalancing group could derive from either 1) the easier stimuli producing a small perdentage of errors, regardless of which training method they were placed under; or 2) the more able Ss being grouped together and performing better under method X, while the less able Ss, also grouped together, performed better under method Y. Should the interaction be due to the former possibility, the method producing the fewest or the most errors should be different for each group; but if the latter possibility were responsible for the interaction, then one should find several groups performing best under the same method.

In Stage Pre-1, the hypothesis involving relative difficulty of stimuli appears more likely. Examination of the errors for individual digits, across all Ss, showed that very few errors were made in naming the digits 1, 2, 3, 8, and 10. Many errors were made on 5, 6, and 9; and 4 and 7 were of medium difficulty. The method in which the fewest errors were made moved around from group to group, with only two of the five groups performing best on the same method. With few exceptions, the method by which 1 and 10 were presented showed the smallest percentage of errors and the method by which 5 and 6 were presented, the largest percentage. It is likely that many of the Ss who were trained in Stage Pre-1 could already identify and label several of the digits at the beginning of the study. Therefore the interaction of method and group in Stage Pre-1 is very likely an interaction of method and stimuli and due primarily to a wide range of difficulty among the items.

A different conclusion can be drawn for Stages 2 and 4A. In Stage 4A, three of the counterbalancing groups made their lowest percentages of errors in condition P-C; the other two groups, in Alt. In addition, there was the before-mentioned difference among the groups in Stage 4A, even though Ss were assigned randomly to groups. The three groups (total of six Ss) performing best under P-C had a mean percentage of errors of 10%. The two groups (four Ss) performing best under Alt, on the other hand, made 27% errors.

To test the hypothesis that the faster learners performed better in P-C while the slower learners performed better in Alt, the percentage of errors made by each S across all conditions in Stage 4A was determined and the Ss were divided into two groups of five on the basis of their percentage of errors. The five Ss making the fewest errors averaged 4% errors in P-C and 16% errors in Alt. The five Ss making the most errors averaged 26% errors in P-C but only 19% in Alt. A percentage difference score (percentage errors in Alt minus percentage errors in P-C) was obtained for each S. A t-test performed on the difference scores indicated that the difference

between the mean difference scores for the two kinds of learners was marginally significant ($t = 2.02$, $df = 8$, $p < .10$). That is, the interaction between learner ability, as measured by overall percentage of errors, and presentation condition was marginally significant.

The interaction of ability with training condition may be seen more clearly in Stage 2. Again, a t-test on percentage difference scores resulted in a significant difference between the fast and slow learners ($t = 2.48$, $df = 8$, $p < .05$). (Only 10 of the 13 Stage 2 Ss were included in the test because two Ss tied for the sixth highest percentage of errors.) Once again, the Ss making few errors overall performed better under P-C (15% errors) than under Alt (18% errors), and the Ss making many errors overall performed better under Alt (28% errors) than under P-C (40% errors).

Thus, in Stages 2 and 4A, it is likely that the interaction of method and group is due to an interaction between method and learning ability (for this one task, at any rate). Such a conclusion is made somewhat more believable by the observation that, although the differences among methods were nonsignificant, the best performance in Stages 1 and 2 occurred under Alt, while the best performance in Stages 3, 4A, and 4B occurred under P-C (Table 3). Alt resulted in better performance than P-C in Stage Pre-1, also, although the best performance in that stage was obtained under C. Thus the early stages, which were easier and/or in which the less able children served as Ss (the more able ones having surpassed those stages before entering the program), were learned best by Alt. The later stages, which were harder and/or in which the more able children served as Ss, were learned best by P-C.

The interaction between ability and training condition might more appropriately be thought of as a hypothesis than as a result, since the number of Ss involved in the tests for it were so few and since the tests were post hoc. However, the findings that 1) in Stages 2 and 4A, the more able Ss learned best under P-C while the less able Ss learned best under Alt, and 2) the early stages, in which the less able Ss were used, were learned best under Alt, while the later stages in which more able Ss were used were learned best under P-C, argue strongly for the hypothesis.

The absence of large differences among the various training procedures should not be interpreted as an absence of any effect on the Ss' arithmetic knowledge. A glance at Table 2 will ascertain that many of the Ss moved through two or more program stages; yet the greatest number of sessions that any one S participated in the program was 34. It appears that the Ss were learning fairly rapidly. The Ss who were run during the spring semester completed a mean of 2.66 stages (counting A and B as a single stage). If the Ss who, because of illness, home visits, etc. were unable to participate more than 15 times are deleted, that average increases to 3.26. The pre-test that had been given in order to place Ss within the program was readministered approximately three weeks after the training sessions had ended. The average gain from the beginning of training (not from the pre-test, which had placed a few Ss too low in the program) to the post-test was 2.57 stages for all the spring semester Ss, and 3.12 stages for the Ss participating in more than 15 sessions. These gain scores were approximately one-tenth of a stage below the end-of-training gain scores (measured by number of stages completed), indicating negli-

gible forgetting over those three weeks.

A more appropriate measure of the effect of the training program would be some arithmetic test other than a sub-set of the training materials. Thus, an attempt was made to obtain achievement test scores from before and after the Ss had participated in the program. Unfortunately, since most of the Ss were selected from Levels 1 and 2 of the educable school (Levels 1 and 2 are approximately equivalent to nursery school and kindergarten), those Ss were not tested for achievement by the school. Achievement tests are usually administered for the first time as the pupil nears the end of Level 3; since a child may remain in each level of the school for two or three years, most of our Ss were still several years removed from their first experience with achievement tests. However, of the Ss in Level 3, five were tested both in the fall of 1969 and in the spring of 1970. Gains in arithmetic reasoning and computation skills for those five Ss were 6 months, 1 year, 6 months, 2 years, and 1 year 1 month, for a mean gain of one full school year plus three months. A gain of this magnitude would be impressive for any group of retarded children. It is especially so here, since when training began these five Ss had an average CA of 12 years 1 month, had been in the residential school classes for an average of 3 years and presumably in other school classes before that, and still could not add!

Pupils in Levels 1 and 2 are rated at the end of each school year on a checklist of skills by their teachers. Here, too, the records were incomplete, but the files of 12 Ss contained entries for both the spring of 1969 and the spring of 1970. Of these, 11 Ss were rated by their teachers as having made some gain in arithmetic concepts. The mean gain for the 12 Ss was large enough to justify transfer of a pupil to the next level (e.g., from Level 1 to Level 2). In fact, seven of these 12 were placed in the next level in the fall of 1970. It is likely that more of them would have been moved upward if their progress in other areas had even approached their progress in arithmetic.

Considering the slow rate at which these Ss and other children enrolled in the school's classes over the past several years had been learning arithmetic, it is unlikely that the fairly large gains made by these 17 Ss were due entirely to the regular school program. A more plausible explanation for at least part of the large gains is the training program described earlier in this chapter.

Thus, the lack of large differences in the effectiveness of the various presentation methods within the training program is not due to a failure of the program to have any effect on the Ss' learning. They did learn, at a rate faster than might be expected to result from their classwork alone. The absence of large differences among presentation methods may reflect the equivalence of these methods, or it may result merely from the small sample of Ss and the small number of training sessions. Nevertheless, the possible interaction between ability and sequence of presentation methods appears worthy of further investigation.

Chapter 4: Practical Applications

The preceding chapters have summarized the studies run in this series, and their results. There are few conclusive statements which can be made on the basis of these studies. Implicit in the report of almost every result is at least one question requiring more research.

But to the practitioner already at work with mental retardates, attempting to teach them either through direct classroom contact or by writing curricula, the statement -- virtually automatic to researchers -- that "more research needs to be done" is of very little value. Educational programs are going to be written, of necessity, before all the needed research can be done. What the practitioner needs, since the ideal methods are not known, is the researcher's best educated guesses about methodology.

The following, then, is an attempt to offer practical suggestions, based on the previous chapters, to those who are teaching mentally retarded children or writing programs for them. The evidence for some of these factors is stronger than for others; and, as was stated above, more research is needed before firm conclusions may be drawn. Nevertheless, as working assumptions, the following seem important:

1. Pace of presentation. Contrary to popular opinion, retarded children should not be allowed to progress at their own rate. The pace they set for themselves is too fast for efficient learning. In a fairly structured task, the rate at which the pupils pace themselves should be ascertained and the rate of presentation then set slightly slower than the self-paced rate.

2. Set for long retention interval. Whenever possible, several tests for the material being learned should be included at longer retention intervals than usual, interspersed throughout the learning program but especially near the beginning of learning. If the child is attempting to remember an item for a long period of time, he is more likely to remember it until the next study trial than if he is trying to remember it only until the next study trial. It is unlikely that admonitions to "try to remember this a long time" will greatly increase retention unless tests are occasionally given at long intervals.

3. Verbalization. The child should orally repeat the material he is attempting to learn, when it is presented to him. Where speaking aloud is impractical, whispered repetition should be encouraged.

4. Intervening tests. In learning tasks which follow a paired-associate format, i.e., tasks which require the learner to pair a different response with each of several stimuli, interspersed tests can increase the rate of learning. Although the effect of a test trial is not as great as that of a study trial, there are often cases where study trials with

feedback as to the correctness of responses cannot occur without the aid of either a teacher or complicated machinery. The pupil may be able to go through the material by himself, however, receiving no feedback and thus effectively giving himself test trials. These test trials, interspersed among the study trials with feedback, should speed his learning.

Note: The effectiveness of the four factors listed above very probably results from increased rehearsal, either overt or covert. Slowing the pace of presentation and including tests trials allow additional time for the child to repeat answers to himself. And it is likely that he will rehearse more when he thinks he must remember the material longer. It cannot be overemphasized that, whenever possible, pupils should be encouraged to repeat responses over and over to themselves while they are trying to learn.

5. Expectancy of success. Motivation to participate in learning tasks varies with the level of institutionalized retardates, and with the factor of institutionalization among educable retardates. Those children who have had few success experiences -- in general, noninstitutionalized educables and (at least) institutionalized trainables, but varying specific subgroups with expectancies of failure might be identified in local populations -- may perform best if a C procedure is used. Presumably, training by C provides visible (to the child) successes early in training and thus increases motivation to continue the task.

6. Importance of particular rewards to the learner. It is advantageous to identify goals of the child and to use attainment of those goals to signal learning successes. For some retardates, the excitement of learning itself or the approval of adults may be enough to maintain learning attempts. For others, a candy bar is much more important; motivation will increase more rapidly and learning will occur faster when candy is given with praise than when the praise is given alone.

7. Interference resulting from similarity within the task. When bits of information that the pupil is asked to learn concurrently are highly similar, better learning may result from the use of a prompting procedure. Presumably, the child gets the items confused because whatever mediator he develops for remembering an answer may lead to an incorrect response almost as easily as it leads to the correct one. The prompt used in the prompting procedure may discourage such overly broad mediation, since the child is told the answer on study trials and thus does not have to attempt an answer early in the learning.

8. Training method as a means of distinguishing tasks. If there is a high probability that two tasks learned consecutively will become confused with each other, the second should be taught by a different method than the first. The training methods will then offer the pupil an additional cue for keeping the tasks separate while he is learning the second one. Thus, some of the confusion which would be expected to occur, and some of the unlearning of the prior task that such confusion could cause, may be averted. If the tasks are taught concurrently, it would seem even more important to teach them by two different methods.

9. Diagnostic nature of training materials. The slow rate at which most mentally retarded children learn argues for using these children's

learning time most efficiently, even if that strategy results in a less efficient use of teacher time. It would thus appear that some means should be found for ascertaining the child's current stage of learning and concentrating his learning attempts on tasks slightly above that stage. In this way, the time the child spends in the classroom will be spent in activities from which he, rather than one of his classmates, learns. With highly structured materials which follow the paired-associate format, such as the materials in our applied study, items appropriate to each child may be selected simply be entering the program at different points. The point at which the child enters the program may be determined by a pre-test based on the contents of the program. As the child moves through the program, a diagnosis of his present knowledge and the items which he should next attempt is possible at any time, since the program's training items also serve as test items. Constant use of the training materials as diagnostic instruments should result in the most efficient use of the child's time.

10. Learner ability. There is some suggestion that more able mental retardates (perhaps those who have already learned the early stages of a given type of learning task) learn most rapidly when they are told the correct responses for several trials and are required to attempt to answer correctly thereafter. Less able mentally retarded children, however, appear to learn more rapidly when they are told the correct answer on the first trial, required to attempt to answer on the second trial, told the correct answer on the third trial, required to attempt to answer on the fourth trial, etc. Note: The learner ability referred to here is ability for a specific task; it is not the generalized ability measured by the WISC.

The research necessary to specify the ideal method for each learning task will take many more experimenter-years. In the meantime, it is hoped that the above suggestions will prove helpful to today's teachers of mentally retarded children.

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Table 1

CAs and IQs of Subjects in the Paradigmatic Studies

	Mean CA	Mean IQ	
Experiment 1 Seitz, 1969a	13.18	58.56	
Experiment 2 Seitz and Sweeney, 1969	15.19	63.09	
Experiment 3 Seitz, 1969b	15.12	60.23	
Experiment 4 Seitz and Morris, 1969	14.58	62.68	
Experiment 5 Seitz and Farmer, 1969	15.33	60.64	(Institutionalized Ss)
	14.12	60.06	(Noninstitutionalized Ss)
Experiment 6 Farmer and Seitz, 1969	15.33	60.64	(Educable Ss)
	14.53	36.02	(Trainable Ss)
Experiment 7 Seitz and Merryman, 1970	14.68	59.90	
Experiment 8 Merryman, Frager, and Seitz, 1970	13.08	56.65	

Table 2

Characteristics of subjects in the applied study, when they entered the study.

Ss run during the spring semester:

S#	CA	IQ	Time spent in the school (yrs. & mos.)	#Sessions	Earliest stage in which error occurred	Last stage completed
1	14- 4	56	5- 2	10	Pre-1	Pre-1
2	11- [illegible]	45	5-10	10	Pre-1	1
3	11- 6	41	7- 6	9	Pre-1	1
4	11- 8	40	3- 2	17	Pre-1	1
5	10- 6	50	0- 3	30	Pre-1	2
6	11- 4	64	1- 2	27	Pre-1	2
7	11- 6	38	4- 9	15	Pre-1	2
8	8- 6	51	4- 0	18	Pre-1	3
9	10- 6	61	4- 5	34	Pre-1	3
10	14- 7	47	4-11	16	Pre-1	3
11	12-10	47	1- 2	32	Pre-1	4A
12	8- 0	55	4- 5	29	Pre-1	4B
13	7- 6	49	0- 9	29	1	2
14	9- 2	40	3- 5	23	1	2
15	11- 3	67	2- 5	17	2	4A
16	10- 2	56	3- 2	29	2	4B
17	10- 4	55	5- 2	26	2	4B
18	10- 7	51	3- 5	22	2	4B
19	11- 5	58	4- 8	26	2	4B
20	12- 9	51	2- 8	24	2	4B
21	12- 0	54	3- 3	20	3	6B
22	15- 4	44	3- 0	13	4A	4B
23	13-10	45	6- 1	15	4B	4B
24	15- 3	54	2- 4	14	5B	5B
25	11-10	61	3- 0	13	5B	6B

Ss run in the summer:

S#	CA	IQ	Time spent in the school (yrs. & mos.)	#Sessions	Earliest stage in which error occurred	Last stage completed
26	12- 6	37	7- 8	3	Pre-1	Pre-1
27	11- 2	53	2-11	6	Pre-1	Pre-1
28	15- 1	29	7- 7	6	Pre-1	Pre-1
29	9- 1	31	5- 0	5	1	1
30	11-10	39	5-10	4	1	1
31	12- 6	69	4-10	8	3	3
32	13- 2	55	3- 6	4	4B	4B

Table 3

Percentage of errors under each presentation method by stages

Presentation Method

Stage	P	C	P-C	C-P	Alt
Pre-1	27.6	26.2	27.3	32.9	26.8
1	13.2	16.9	16.8	10.9	8.4
2	22.9	24.4	20.5	19.7	16.7
3	17.1	20.4	13.0	19.0	17.4
4A	18.0	16.0	14.8	17.3	17.7
4B	34.1	32.2	29.0	29.3	35.1

Appendix

Applied Study Instructions

Below are the instructions used in Stages Pre-1, 1, and 4A. Instructions for the other stages followed the same format, but the description of stimuli differed across stages.

Stage Pre-1

Beginning of session, Day 1

I'm going to show you some numbers. Each number has a name. The names are 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10. When I show you a number, sometimes I'll tell you what it is called. If I tell you the name, you say it after me, and look hard at the number so you can remember its name the next time. Sometimes I won't tell you the name of the number; when I don't tell you its name, you tell me what you <u>think</u> it's called. If you don't know for sure, <u>guess</u>. Then I'll tell you what the name is. You look at the number real hard, say it, and try to remember its name until the next time. O.K.? When I tell you what the number is called, you say its name after me. When I don't tell you, you guess what the name is. Let's try a few.

(For the first few trials, it may be necessary to coach the <u>S</u>. On P trials, if <u>S</u> says nothing, say "Say it after me" and repeat the number. On C trials, if <u>S</u> is silent, say "What do you think the name of this one is?" or "What is this number called?" or "What is this one's name?" or "What is this one?"

Use verbal praise throughout. On P trials, after <u>S</u> repeats the number, say "Good" or "That's right, it's <u>6</u>." On C trials, say "You're right. It's <u>6</u>. Good." or "No. It's <u>6</u>." Accent the number name in these statements.)

Beginning of session, except Day 1

I'm going to show you the same numbers you saw last time. Try to learn as many of them as you can. Remember to say the name after me when I tell you what a number is. Look hard at each one after you find out its name so you can remember it the next time. O.K.?

Before test trial

This time, I won't tell you what the numbers are. You look close at each one and tell me what you think it's called. What is this one?

(You may have to say several times during the first test, "I'm not telling you the names this time.")

Before practice trial following test trial

That was good. Now this time, I'll tell you what some of the numbers are and you say the name after me; if I don't tell you, you tell me what you think they are, and then I'll tell you the name. Just like before. Remember to look at the numbers and try to remember their names.

Before first stage using slides, for a given S

I'm going to show you some cards. They have one picture at the top and three pictures at the bottom. I want you to tell me which of the pictures at the bottom is like the picture at the top. (Present picture card.)

Let's see if you are right. (Show underlined picture card next to first picture card.) Yes! See, this one is right (point to underlined picture) and that's what you said. Good.

---OR---

No. See, this one is right (point to underlined choice) and you said this one (point to his choice). Now, which picture goes with the one at the top? .... Good.

Now look at this one. Which one of the pictures at the bottom is like the picture at the top? Say the number under it. (Present the first card bearing groups of squares.)

Let's see if you are right. (Show underlined squares card next to first squares card.) Yes! See, this one --3-- is right, and you said 3. Good.

---OR---

No. See, this one --3-- is right, and you said _____. (point to the two choices.) Now, which of the squares at the bottom goes with the squares at the top? .... Good.

Now, how about this one? (Present second squares card, with 7 underlined.) How many squares are there at the top?

Good. That's right. The right one is the one that's underlined.

---OR---

No. Look again. The right one is the one that's underlined. Which one

of these at the bottom goes with the squares at the top? .... Good.

GO TO FIRST DAY INSTRUCTIONS FOR THE RELEVANT STAGE.

Stage 1

Beginning of session, Day 1

Now I'm going to show you some slides. (Turn on Slide 1.) They all have pennies at the top, and some groups of pennies at the bottom. I want you to find the pennies at the bottom that go with the pennies at the top. Point to them and say the number that's under them. The number tells how many pennies there are at the top. Then I'll show you the same slide with the right answer underlined and you can point to the right answer and say the number under it. Sometimes I'll just show you the slide with the underlined answer, and you'll point to it and say the number. When you find out how many pennies there are at the top, look at them close and try to remember how many there are until the next time.

Beginning of session, except Day 1

I'm going to show you the same slides you saw last time. Try to learn as many of them as you can. Remember to say the number that is underlined, because that tells how many pennies there are. If no number is underlined, pick the number you think tells how many pennies there are, and say it. Look hard at each slide after you find out how many pennies there are so you can remember the next time.

Before test trial

This time, none of the numbers will be underlined on any of the slides. You look close at each slide and tell me how many pennies there are at the top of the slide. How many pennies are on this one?

Before practice trial following test trial

That was good. Now this time, some of the slides will have the right number underlined; when a number is underlined, that tells how many pennies there are, so you say that number. If none of the numbers are underlined, pick the number that you think tells how many pennies there are, and say it. Just like before. Remember to look close at the pennies so you can tell how many there are.

Stage 4A

Beginning of session, Day 1

You have done a real good job of learning the numbers. Now we are going to use those numbers to add. I'm going to show you some slides that are a little different from the ones I've showed you before. (Turn on Slide 1.) These have two numbers at the top, with a plus sign between them. So this slide has _____ + _____ at the top. And there are some little green houses above each number, with as many houses over each number as that number says. So there are _____ houses over the _____ and _____ houses over the _____. The "plus" means that we are going to put these two groups of houses together and say how many houses there are when they are all together. When you see a slide, read what it says at the top; this one says _____ + _____. Then pick the number at the bottom that tells how many you get when you put those two numbers together, and say it. When the right number is underlined, read what it says at the top and then say the number that's underlined. Remember to look close at the slides when you find out the answer so you will remember it the next time. Let's try a few. What does this one say at the top? .... And how many do you get when you put _____ and _____ together?

Beginning of session, except Day 1

I'm going to show you the same slides you saw last time. Try to learn as many of them as you can. Remember to read what is at the top of the slide. And then say the number that is underlined, because that number is how many you get when you put the houses at the top together. If no number is underlined, say the number that you think tells how many you get when you put the houses at the top together. When you find out what the answer is, look close at the slide and try to remember it until the next time. O.K.? What does this one say at the top? .... And how many do you get when you put _____ and _____ together?

Before test trial

This time, none of the numbers will be underlined on any of the slides. Read what each slide says at the top, and then pick the number at the bottom you think is right and say it. O.K.; what's this one?

Before practice trial following test trial

That was good. This time, some of the slides will have the answer underlined and some won't, just like before. When you see a slide, read what it says at the top. Then say the number at the bottom that tells how many you will get when you put the houses at the top together. When one of the numbers is underlined, say it because that's how many houses you would get. When you find out the answer, look at the slide and try to remember the answer until the next time.